Supplementary Material

Article

Hydrogeochemical and Isotopic Characteristics of the Hot Springs in the Litang Fault Zone, Southeast Qinghai–Tibet Plateau

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Item 1: The calculation of the ratio of 10 Mg/(10 Mg + Ca) and 10 K/(10 K + Na) for 10 Mg/(10 Mg+ Ca) vs. 10 K/(10 K + Na) binary diagram.

Firstly, the Na, K, Ca and Mg concentrations of the measured constant elements (mg/L) were transformed into mol/L. Then, the values of x-axis and y-axis were calculated according to the forluma 10 K/ (10 K + Na) and 10 Mg/ (10 Mg + Ca), and the figure of 10 Mg/(10 Mg + Ca) vs. 10 K/(10 K + Na) were plotted using Grapher 17.3 software. Finally, the criteria curve for distinguish the reservoir temperature was marked in the graphs according to previous literatures.

Item 2: The geothermometer equations for reservoir temperatures (°C) estimation in the LFZ are as follows.

Quartz, no steam loss: $T = \frac{1309}{5.19 - \log SiO_2} - 273.15$

Quartz, maximum steam loss: $T = \frac{1522}{5.75 - \log SiO_2} - 273.15$

Chalcedony, no steam loss: $T = \frac{1032}{4.69 - \log SiO_2} - 273.15$

Chalcedony, maximum steam loss: $T = \frac{1246}{5.31 - \log SiO_2} - 273.15$

Na/K: $T = \frac{1390}{\log\left(\frac{Na}{K}\right) + 1.75} - 273.15$

Na/Li: $T = \frac{1590}{\log\left(\frac{Na}{Li}\right) + 0.779} - 273$

Li-Mg: $T = \frac{2200}{\log\left(\frac{Mg^{0.5}}{Li}\right) + 5.47} - 273$

Na-K-Ca: $T = \frac{1647}{\{\log\left(\frac{Na}{K}\right) + \frac{1}{3} \times [\log\left(\frac{Ca^{\frac{1}{2}}}{Na}\right) + 2.06] + 2.47\}} - 273$

Ca/Mg: $T = \frac{896}{3.408 - \log\left(\frac{Ca}{Mg}\right)} - 273.15$

Item 3: Silicon-enthalpy model calculation.

The silicon enthalpy mixing model is based on the enthalpy of cold and hot water and the content of SiO_2 mixed in different proportions, resulting in the enthalpy of underground hot water and SiO_2 finally showing the state of exposed hot spring.

The model equation is:

$$S_c X_1 + S_h (1-X_1) = S_s \quad (1)$$

$$SiO_{2c} X_2 + SiO_{2h} X_2(1-X_2) = SiO_{2s} \quad (2)$$

where S_c is enthalpy of cold water (J/g), S_s is the final enthalpy of hot spring water (J/g). The enthalpy of saturated water below 100°C equals to the Celsius temperature of the water; when the temperature is above 100°C, the relationship between temperature and saturated water enthalpy can be found in the Table SM1. S_h is the initial enthalpy of hot water(J/g); SiO_{2c}, SiO_{2h} and SiO_{2s} are SiO_2 mass concentration of surface cold water, hot water and hot spring water (in mg/L). X is the mixing proportion of cold water.

Previous study has shown that the temperature of Litanghe River water sample is 12.7°C, and the concentration of SiO_2 is less than 0.1 mg/L, in order to facilitate the calculation of SiO_2 concentration is 0.1 mg/L. The temperature of hot spring water and SiO_2 mass concentration of the hot spring have been measured in this study.

Table SM1 Relationship of water temperature, enthalpy and mass concentration of SiO_2

T(°C)	Enthalpy(J/g)	$\rho_c(SiO_2)$ (mg/L)	T(°C)	Enthalpy(J/g)	$\rho_c(SiO_2)$ (mg/L)
50	50	13.5	200	203.6	265
75	75	26.6	225	230.9	365
100	100.1	48	250	259.2	486
125	125.1	80	275	289	614
150	150.1	125	300	321	692
175	177	185			

In the silicon-enthalpy model, the x-axis value of the intersection point of the silicon curve and the enthalpy curve is thermal reservoir temperature, and the y-axis value is the mixing ratio of cold water.